

What is claimed is:

1. A method of forming a composite tungsten film, comprising:  
sequentially depositing tungsten nucleation layers and tungsten bulk layers on a substrate to form a composite tungsten layer, wherein each of the tungsten nucleation layers and the tungsten bulk layers have a thickness less than about 300 Å.
2. The method of claim 1 wherein each of the tungsten bulk layers has a thickness within a range of about 150 Å to about 250 Å.
3. The method of claim 1 wherein each of the tungsten nucleation layers has a thickness within a range of about 15 Å to about 50 Å.
4. The method of claim 1 wherein the composite tungsten film has a thickness within a range of about 500 Å to about 3000 Å.
5. The method of claim 1 wherein each of the tungsten nucleation layers is deposited by alternately adsorbing a tungsten-containing precursor and a reducing gas on the substrate.
6. The method of claim 5 wherein the tungsten-containing precursor is selected from the group consisting of tungsten hexafluoride (WF<sub>6</sub>) and tungsten carbonyl (W(CO)<sub>6</sub>).
7. The method of claim 5 wherein the reducing gas is selected from the group consisting of silane (SiH<sub>4</sub>), disilane (Si<sub>2</sub>H<sub>6</sub>), dichlorosilane (SiCl<sub>2</sub>H<sub>2</sub>), borane (BH<sub>3</sub>), diborane (B<sub>2</sub>H<sub>6</sub>), triborane (B<sub>3</sub>H<sub>9</sub>), tetraborane (B<sub>4</sub>H<sub>12</sub>), pentaborane (B<sub>5</sub>H<sub>15</sub>), hexaborane (B<sub>6</sub>H<sub>18</sub>), heptaborane (B<sub>7</sub>H<sub>21</sub>), octaborane (B<sub>8</sub>H<sub>24</sub>), nanoborane (B<sub>9</sub>H<sub>27</sub>) and decaborane (B<sub>10</sub>H<sub>30</sub>).

8. The method of claim 5 wherein the tungsten nucleation layer is deposited at a temperature within a range of about 200 °C to about 400 °C.

9. The method of claim 5 wherein the tungsten nucleation layer is deposited at a pressure within a range of about 1 torr to about 10 torr.

10. The method of claim 1 wherein each of the tungsten bulk layers is deposited by thermally decomposing a gas mixture comprising a tungsten-containing precursor.

11. The method of claim 10 wherein the tungsten-containing precursor is selected from the group consisting of tungsten hexafluoride (WF<sub>6</sub>) and tungsten carbonyl (W(CO)<sub>6</sub>).

12. The method of claim 10 wherein the tungsten bulk layer is deposited at a temperature within a range of about 450 °C to about 650 °C.

13. The method of claim 10 wherein the tungsten bulk layer is deposited at a pressure within a range of about 10 torr to about 30 torr.

14. The method of claim 1 wherein the tungsten nucleation layers are deposited in a different process chamber than that used to deposit the tungsten bulk layers.

15. The method of claim 1 wherein the tungsten nucleation layers are deposited in the same process chamber used to deposit the tungsten bulk layers.

16. A method of forming a composite tungsten film, comprising:  
sequentially depositing tungsten nucleation layers and tungsten bulk layers on a substrate to form a composite tungsten layer, wherein each of the tungsten nucleation layers is deposited by alternately adsorbing a tungsten-containing precursor and a reducing gas on the substrate and wherein each of

the tungsten bulk layers is deposited by thermally decomposing a gas mixture comprising a tungsten-containing precursor.

17. The method of claim 16 wherein each of the tungsten bulk layers has a thickness within a range of about 150 Å to about 250 Å.

18. The method of claim 16 wherein each of the tungsten nucleation layers has a thickness within a range of about 15 Å to about 50 Å.

19. The method of claim 16 wherein the composite tungsten film has a thickness within a range of about 500 Å to about 3000 Å.

20. The method of claim 16 wherein the tungsten-containing precursor is selected from the group consisting of tungsten hexafluoride (WF<sub>6</sub>) and tungsten carbonyl (W(CO)<sub>6</sub>).

21. The method of claim 16 wherein the reducing compound is selected from the group consisting of silane (SiH<sub>4</sub>), disilane (Si<sub>2</sub>H<sub>6</sub>), dichlorosilane (SiCl<sub>2</sub>H<sub>2</sub>), borane (BH<sub>3</sub>), diborane (B<sub>2</sub>H<sub>6</sub>), triborane (B<sub>3</sub>H<sub>8</sub>), tetraborane (B<sub>4</sub>H<sub>12</sub>), pentaborane (B<sub>5</sub>H<sub>15</sub>), hexaborane (B<sub>6</sub>H<sub>18</sub>), heptaborane (B<sub>7</sub>H<sub>21</sub>), octaborane (B<sub>8</sub>H<sub>24</sub>), nanoborane (B<sub>9</sub>H<sub>27</sub>) and decaborane (B<sub>10</sub>H<sub>30</sub>).

22. The method of claim 16 wherein the tungsten nucleation layer is deposited at a temperature within a range of about 200 °C to about 400 °C.

23. The method of claim 16 wherein the tungsten nucleation layer is deposited at a pressure within a range of about 1 torr to about 10 torr.

24. The method of claim 16 wherein the tungsten bulk layer is deposited at a temperature within a range of about 450 °C to about 650 °C.

25. The method of claim 16 wherein the tungsten bulk layer is deposited at a pressure within a range of about 10 torr to about 30 torr.

26. The method of claim 16 wherein the tungsten nucleation layers are deposited in a different process chamber than that used to deposit the tungsten bulk layers.

27. The method of claim 16 wherein the tungsten nucleation layers are deposited in the same process chamber used to deposit the tungsten bulk layers.

28. A method of forming a composite tungsten film for use in a memory cell, comprising:

providing a substrate structure, wherein the substrate structure includes an insulating material having at least one aperture therein; and

sequentially depositing tungsten nucleation layers and tungsten bulk layers on a substrate to form a composite tungsten layer, wherein each of the tungsten nucleation layers and the tungsten bulk layers have a thickness less than about 300 Å.

29. The method of claim 28 wherein each of the tungsten bulk layers has a thickness within a range of about 150 Å to about 250 Å.

30. The method of claim 28 wherein each of the tungsten nucleation layers has a thickness within a range of about 15 Å to about 50 Å.

31. The method of claim 28 wherein the composite tungsten film has a thickness within a range of about 500 Å to about 3000 Å.

32. The method of claim 28 wherein each of the tungsten nucleation layers is deposited by alternately adsorbing a tungsten-containing precursor and a reducing gas on the substrate.

33. The method of claim 32 wherein the tungsten-containing precursor is selected from the group consisting of tungsten hexafluoride (WF<sub>6</sub>) and tungsten carbonyl (W(CO)<sub>6</sub>).

34. The method of claim 32 wherein the reducing compound is selected from the group consisting of silane (SiH<sub>4</sub>), disilane (Si<sub>2</sub>H<sub>6</sub>), dichlorosilane (SiCl<sub>2</sub>H<sub>2</sub>), borane (BH<sub>3</sub>), diborane (B<sub>2</sub>H<sub>6</sub>), triborane (B<sub>3</sub>H<sub>9</sub>), tetraborane (B<sub>4</sub>H<sub>12</sub>), pentaborane (B<sub>5</sub>H<sub>15</sub>), hexaborane (B<sub>6</sub>H<sub>18</sub>), heptaborane (B<sub>7</sub>H<sub>21</sub>), octaborane (B<sub>8</sub>H<sub>24</sub>), nanoborane (B<sub>9</sub>H<sub>27</sub>) and decaborane (B<sub>10</sub>H<sub>30</sub>).

35. The method of claim 32 wherein the tungsten nucleation layer is deposited at a temperature within a range of about 200 °C to about 400 °C.

36. The method of claim 32 wherein the tungsten nucleation layer is deposited at a pressure within a range of about 1 torr to about 10 torr.

37. The method of claim 28 wherein each of the tungsten bulk layers is deposited by thermally decomposing a gas mixture comprising a tungsten-containing precursor.

38. The method of claim 37 wherein the tungsten-containing precursor is selected from the group consisting of tungsten hexafluoride (WF<sub>6</sub>) and tungsten carbonyl (W(CO)<sub>6</sub>).

39. The method of claim 37 wherein the tungsten bulk layer is deposited at a temperature within a range of about 450 °C to about 650 °C.

40. The method of claim 37 wherein the tungsten bulk layer is deposited at a pressure within a range of about 10 torr to about 30 torr.

41. The method of claim 32 wherein the tungsten nucleation layers are deposited in a different process chamber than that used to deposit the tungsten bulk layers.

42. The method of claim 32 wherein the tungsten nucleation layers are deposited in the same process chamber used to deposit the tungsten bulk layers.
43. The method of claim 32 wherein the composite tungsten film is used for at least one of word and bit metallization in the memory cell.

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